Peat Marwick

NOVA SCOTIA
DEPARTMENT OF TRANSPORTATION

HALIFAX LOAD CENTRE COST ANALYSIS

FINAL REPORT

Submitted by

PEAT MARWICK CONSULTING GROUP

in association with

MAUGHAN RAILWAY CONSULTING SERVICES INC.

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March 31, 1988

Nova Scotia Department of Transportation
Halifax, Nova Scotia

Attention: Mr. D.J. MacDougall — Director, Transportation Policy

Gentlemen:

Halifax Load Centre Cost Analysis

The accompanying report describes the results of our investigations on the above subject. This introductory letter provides a brief overview of the study's objectives and findings.

OBJECTIVES AND SCOPE

The overall objective of the study is described in the Terms of Reference as follows:

> *"The purpose of the study is to determine the impact on the Port of Halifax of an increase in rail container rates. In Addition, to determine how the components or elements in the container transport system could be made more efficient in order to reduce the effects of cost increases in any other element."*

The scope of work is delineated in terms of four specific issues, as follows:

1. Determine impact of increased motor vehicle weights and dimensions on rail variable cost and compensatory rate.

2. Estimate comparative cost to shipping lines of service via Halifax, New York, and Norfolk.

3. Explore opportunities for reducing cost of container movement via Halifax, particularly considering new technology.

4. Determine whether the condition of the CN Halifax-Moncton rail line could cause present or future operational problems for the movement of containers.

FINDINGS

Our findings are reported separately for the issues outlined above.

Impact of Increased Vehicle Weights and Dimensions on Rail Variable Costs and Rates

Loss of rail traffic due to increased competitiveness of truckers using larger motor vehicles would result in increased rail variable costs. These cost increases would occur because, generally speaking, CN's trains would be smaller and therefore less efficient.

The impact of the subject traffic loss on the size and economics of CN's container trains would be comparatively modest, due to the fact that these trains are largely composed of import/export container traffic, which is not susceptible to diversion to truck carriage. We estimated that the variable costs and rates for CN's container rail service would eventually increase by approximately 5% if the larger motor vehicles proposed in the RTAC/CCMTA September 1987 report *"Recommended Regulatory Principles for Interprovincial Heavy Vehicle Weights and Dimensions"* had been implemented.

At their February 12, 1988 meeting in Toronto, however, the provincial ministers of transportation opted to retain the 48-ft. trailer length as the maximum size which could operate in all jurisdictions. They also agreed to accept double trailers, on selected highways with an overall length of 23 metres, an increase from 21 metres in Atlantic Canada.

The 25% traffic loss which CN estimated would result from implementation of the proposals will therefore not occur. The traffic loss will be substantially less as a result of retention of the

48-ft. trailers, and the resultant increase in the CN Rail variable costs and rates will therefore be significantly less than the 5% estimated.

Comparative Cost of Shipping Line Service via Halifax versus Competing Ports

The costs of service via the Port of Halifax were compared with the costs of service via New York and Hampton Roads (Norfolk and Portsmouth terminals). This comparison incorporated all relevant costs including vessel diversion to Halifax, port costs, container handling (i.e, stevedoring) costs, and inland transportation costs. The analysis was conducted for both services to/from Europe and to/from southern origins/destinations, as well as for both Montreal and Toronto origins/destinations.

The cost of service via Halifax to shipping lines was found to compare favorably with the costs via both New York and Hampton Roads for the representative vessels and services evaluated. Service via Halifax is less costly than via competing ports, except in the case of voyages where the number of containers discharged and/or loaded at Halifax is small in comparison with the capacity of the ship in service. The marine carriers contacted in the course of our work spoke well of the level of service provided by the Port of Halifax.

Container Terminal Technology

State-of-the-art terminal technology was identified and its potential applicability to the Halifax container terminals was evaluated. Our assessment included state-of-the-art Gantry cranes, mechanized terminal handling systems, and the use of advanced information technology.

The equipment and technology currently employed at Halifax was generally found well suited to the port's traffic. Some of the more advanced equipment and systems currently available would be uneconomic at Halifax's volume level. The following technologies warrant consideration for Halifax:

- Terminal operations control systems;
- Multi-trailer yard movement;
- Electronic Data Interchange (EDI).

Of the above, EDI is currently being implemented by both of Halifax's container terminals, and advanced terminal operations control systems are also being seriously considered by the terminal operators.

Double-stack Rail Service

Double-stack rail service has been highly successful in the U.S., particularly for service to/from west coast ports, where the prevailing traffic is better suited to double-stack operations than traffic served by the Port of Halifax. Two key factors which adversely affect the economics of double-stack rail service for Halifax are the heavy average weights of containers, and the lack of sufficient traffic to support full-size double-stack trains.

The cost of double-stack train service for Halifax was analyzed in comparison with the cost of CN's existing single-stack service, taking into account the conditions under which such a service would probably have to operate for the immediate future years (i.e., mixed double-stack/single-stack service). We estimated that double-stack service would achieve savings in the order of 20% of existing rail service costs.

While the potential savings are significant, they appear insufficient to induce CN to invest in double-stack equipment at this time. It would be expected that some of the savings would be passed on to the steamship lines, and the savings retained by CN would not provide sufficient return on investment in the new cars, taking into account that the railways' existing conventional container cars would probably become surplus to its requirements.

We believe, however, that the economics of double-stack are sufficiently attractive that double-stack rail service will become a reality at Halifax within the foreseeable future.

Moreover, implementation of double-stack in the near-term would benefit promotion of the Halifax containerport image. It would demonstrate that Halifax is "state-of-the art", and confirm Halifax as a low cost route. We therefore recommend that parties interested in the port take action to implement an initial double-stack operation at Halifax, probably one of modest scale. A carefully planned and well supported initiative will be needed to launch this ground-breaking service.

Halifax-Moncton Rail Line

Information on the condition of CN's Halifax-Moncton rail line was obtained by a track and roadway specialist by means of a trip over the line, together with review of data on the type of track construction, the nature of maintenance work, the speed and volume of traffic, and other factors. The subject rail line is CN's principal main line in the area and is constructed and maintained to standards consistent with this function.

Overall, the track structure and its condition were found to be satisfactory for the traffic being handled and the permissible train speeds (which are typical of speeds on CN's principal main track across Canada). Presuming continuance of the present quality of track through the necessary maintenance input and component renewal, there is no reason to expect significant operational problems attributable to track condition.

* * * * * * *

We wish to acknowledge the valued cooperation and assistance by Canadian National in the conduct of our work, particularly the courtesy and facilities provided in our inspection of the Halifax-Moncton rail line.

We have appreciated this opportunity of assisting the Nova Scotia Department of Transportation in assessing various factors relating to the future of the Port of Halifax container service, and trust that our findings will prove useful.

Yours truly,

PEAT MARWICK CONSULTING GROUP

F.E. Collins
Partner

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Encs.

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I. INTRODUCTION

This chapter outlines the background, objectives and approach for the study.

BACKGROUND

The study was motivated by changes to truck weights and dimensions which have been proposed by the Roads and Transportation Association of Canada (RTAC) and the Canadian Council of Motor Transport Administrators (CCMTA). The increase in allowable vehicle sizes is considered by CN Rail to be potentially damaging to the railway's traffic, to the extent that it might threaten the Port of Halifax container traffic because rail rates might have to increase.

The Port of Halifax has been successful in developing a major containerport which has attracted service by a number of shipping lines. The containerport serves a large volume of traffic destined to/from Upper Canada, the Atlantic Provinces, and New England, to the extent that it has been characterized as an intermodal load centre. The financial viability of the Halifax Load Centre depends upon efficient, low cost rail container transportation between Halifax and Upper Canada. A substantial increase in the container rail rates might divert traffic to another port. A loss of traffic and shipping line service would result in a significant economic loss to the Port of Halifax, as well as a substantial indirect loss to industry located in the Maritime Provinces which is dependent upon convenient and economic marine transportation to/from overseas markets and sources of supply.

In view of the above, the Nova Scotia Department of Transportation commissioned the study to evaluate the extent to which the economic viability of the Halifax containerport may be impaired as a result of the RTAC/CCMTA truck weights and dimensions proposals. The study also incorporates investigation of other issues related to the ongoing viability of the Halifax containerport and its associated transportation system.

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The overall objective of the study is described in the Terms of Reference as follows:

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1. Determine impact of increased motor vehicle weights and dimensions on rail variable cost and compensatory rate.
2. Estimate comparative cost to shipping lines of service via Halifax, New York, and Norfolk.
3. Explore opportunities for reducing cost of container movement via Halifax, particularly considering new technology.
4. Determine whether the condition of the CN Halifax - Moncton rail line could cause present or future operational problems for the movement of containers.

The above issues are interrelated. Assessment of the first issue (i.e., prospective rail rate increases) provides an indication of the extent of the potential problem to be faced by the Port of Halifax. Information on the second issue (i.e., comparative port costs) provides a basis of determining whether the rail rate increase could threaten the port's competitive position. The third and fourth issues represent additional matters which could affect the ongoing viability of the Halifax containerport.

APPROACH

An orientation meeting with the Steering Committee was held to launch the study, followed by a full-day meeting with CN representatives to obtain initial information. The four study issues were then dealt with as follows:

1. A prototype container train operation was developed for the purpose of exploring rail variable costs. The impact on variable cost of reduced train size was estimated using one of Peat Marwick's rail costing models. The probable reduction in container train

size resulting from CN traffic losses to trucking was assessed, on the basis of which the rail variable cost and container rate increase were determined.

2. Transportation system costs to shipping lines via Halifax and alternative ports consist of port charges, terminal (stevedoring) charges, overland transportation costs and differential ship costs. Each component of these cost categories was researched through extensive fact-finding with shipping lines, port authorities, terminal operators, and overland carriers.

3. The principal opportunities for container transportation system cost reduction are associated with the marine terminal operation and the rail movement. The prospective contribution of high productivity container handling equipment was explored. The possibility of introducing double-stack rail service was assessed, together with the resulting reduction in rail costs.

4. The condition of the Halifax-Moncton rail line was observed during an on-site inspection of the line conducted by a railway track and roadway engineering specialist. CN cooperated in this effort by providing access to the plant and their engineering staff, as well as inspection car facilities. Supplementary data on the rail line construction and maintenance was also provided by CN.

REPORT STRUCTURE

The report structure follows along the lines of the four study issues, with the results for the various issues presented in the same order as they have been described above.

II. RAILWAY COSTS AND RATES

CONTEXT AND METHODOLOGY

The increases in allowable truck weights and dimensions proposed by RTAC/CCMTA would lead to an increase in the productivity of motor carriers. This, in turn, is expected to lead to motor carrier rate reductions and a consequent loss of traffic for CN and other railways.

CN has estimated the magnitude of this loss for CN traffic in the Atlantic provinces. Separate estimates were made by commodity, location and major shipper (where the traffic was small, estimates were made on a more global basis). These estimates were made by CN staff knowledgeable in the commodities and geographic areas involved, taking into account the contribution levels (i.e., profit margins) of existing rates for the subject traffic, and its suitability for carriage by truck. Results varied by type of traffic, but amounted to a loss of 25% for the Atlantic provinces as a whole.[1]

We were shown the results of CN's customer-by-customer analysis, and were permitted to discuss it with CN representatives. We were therefore able to assess the logic and reasonableness of CN's work. However, we were not provided with sufficient information to make an independent estimate of CN's traffic loss. CN's analysis appears to have been carried out in a careful fashion by knowledgeable CN staff. In one instance, traffic lost due to factors other than the RTAC proposal seems to have been included. Otherwise, we found nothing questionable in CN's traffic analysis. Accordingly, we believe CN's traffic loss estimate to be reasonable and have accepted CN's figures as a starting point for our own analysis.

This traffic loss is said by CN to lead to an increase in variable cost for the remaining traffic. In the case of containers, this cost increase is said to require an increase in the rate to ensure that it remains compensatory. The term "compensatory" is defined in legislation[2] and carries a number of connotations. A compensatory rate is one which exceeds the variable cost of moving the traffic concerned. Jurisdiction over the determination of variable cost rests with the

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1 This is described by CN as a "first round" loss. In addition, a subsequent second round of traffic losses was attributed to the cost increase caused by this first round.

2 National Transportation Act, 1987 Section 112 (2), (3), (4).

National Transportation Agency (NTA) — previously Canadian Transport Commission — which has established definitive rules and procedures for this purpose.

It is obvious that a loss in traffic will increase the fixed cost burden to be borne by the remaining traffic. However, the notion that a decline in traffic can lead to an increase in **variable** cost is counter-intuitive. Since variable cost varies with traffic, it would be expected to decline in proportion to traffic losses, leaving the variable cost of the remaining traffic unaffected. Nevertheless, CN has made a plausible case for such a cost increase, based on the cost and service characteristics of their Atlantic region.

A key assumption in CN's analysis is that CN service in the Atlantic provinces is at a "rock bottom" level. CN believe the number of trains per week cannot be cut any further without loss of credibility as a viable transportation service. Similar considerations apply to switching. Adjustments in the face of traffic loss would therefore take the form of running shorter trains and incurring more unproductive time by switch crews, rather than running fewer trains or calling out fewer switch crews.

A number of items of railway cost can be identified as shared variable costs, that is, costs related to, and variable with, train and switching operations as a whole rather than to the addition or subtraction of, say, one car to the train or to the "cut" of cars to be switched. Train crews are an example of such costs. In the event of a decline in traffic under the conditions outlined above (i.e. with service at a "rock bottom" level), these costs would behave in a fashion similar to fixed costs. The shared cost would not decline and would have to be shared out on a smaller traffic base, resulting in an increased cost per carload or per container.

This can be illustrated as follows. Assume a train with 50 cars, having shared variable costs (e.g. crew wages, caboose costs, dispatching costs etc.) of $100, or two dollars per car. If the train loses 10 cars, this same $100 must be shared among the remaining 40 cars, resulting in a variable cost of $2.25 per car (a 12.5% increase in variable cost).

CN quantified this relationship between traffic and cost as follows. First, the variable cost of their present train operations in the Atlantic region was estimated. This was carried out by type of traffic (e.g. containers, carload, piggyback). Key characteristics of the trains involved were identified from CN computer files. Costing methods used by CN for internal purposes were

applied. This involved some deviation from NTA-approved methods. Costs were then re-estimated assuming a 25% reduction in traffic. The results varied by type of traffic. For containers, CN found a 15% to 16% cost increase.[3]

Peat Marwick conducted independent investigations and analysis to assess the probable effects on variable costs for container movements. Some of CN's data and findings were adopted as a starting point. First, a rail cost model was developed and tested against CN's results. This model was based upon a prototype container train considered to be representative of CN's Atlantic Region container trains. The model was then used to estimate the cost effects of traffic declines of various magnitudes. The decline in the size of the trains carrying containers (and the resulting variable cost increase) was estimated based on a general knowledge of container train operations and on CN's estimates of traffic losses in the region. Finally, CN's categorization of certain costs as shared variable cost was questioned, and cost increases were recalculated based on a more restricted set of shared costs. Research procedures and results are explained in more detail in the two following sections.

All quantitative work was conducted in terms of percent changes in variable cost. As stipulated in the Terms of Reference, the rail tariff was assumed to be presently just above the variable cost of the rail movement. Any increase in variable cost was assumed to require a corresponding rate increase to maintain the compensatory nature of the rate.

IMPACT OF TRAIN SIZE ON VARIABLE COSTS

As noted above, a cost model was developed for a prototype container train, based on previous Peat Marwick costing work for movements similar to those under study. Cost methods employed were those approved by the NTA (with some exceptions due to lack of access to confidential data). Cost elements identified by CN as shared train costs were treated similarly in the cost model.

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[3] A smaller (13%) increase was used by CN in subsequent analyses for reasons of conservatism.

A reduction in traffic of 25% was modeled on the assumption that the shared cost elements would not decline, but would be shared among the smaller traffic base. This resulted in cost increases of 16.4%, compared to CN's estimated cost increases for container traffic of 15% to 16%. This suggested the model could be used for further testing, since:

- this result is reasonably close to CN's;
- the difference with CN's results is in a direction favourable to CN's case, i.e., the model does not appear to introduce factors prejudicial to CN's argument;
- differences between the two analyses may be due to the fact that CN used internal costing methods which included some deviations from NTA-approved methods.

In addition to testing or calibrating the model, this analysis (a 25% traffic loss, leading to a 16.4% cost increase) was used as a base case or starting point for further analyses.

The cost model was used to estimate variable cost increases resulting from various degrees of traffic loss ranging from zero to thirty percent. The results were as follows:

Decline in Traffic	*Variable Cost Increase*
0%	0%
5%	2.6%
10%	5.4%
15%	8.6%
20%	12.2%
25%	16.4%
30%	21.0%

As previously noted, all of the above cost figures embody CN's assumptions concerning the elements of shared cost relevant to the analysis of reduced traffic.

ESTIMATED DECREASE IN CONTAINER TRAIN SIZE

As demonstrated above, the variable cost effects of traffic loss are directly related to the reduction in train size. CN assumed that the size of all Atlantic Region trains would be reduced

by twenty-five percent in conducting their cost analyses. While this assumption may be satisfactory to describe a general average condition, it is not sufficient for the determination of cost effects for individual traffic components, such as the container movements. It is therefore necessary to analyze individual train services. However, CN representatives were not prepared to make available any information on train consists. Accordingly, we were obliged to make our own assessments of train consists using relevant available information.

The extent to which container trains would participate in the prospective general decline in train sizes in the Atlantic region as a whole depends on the nature of container train operations. At one extreme, a "pure" unit train made up entirely of containers would be largely isolated from the effects of changes in other traffic. At the other extreme, container traffic would be mixed in with other traffic in a random fashion and would share equally in any increases or decreases in train size or unproductive switching time.

The available information on container operations suggest that container trains lie somewhere between the two extremes portrayed here, but are closer to the unit train model than a random mix. Container traffic is a large component of the total traffic moving between a limited number of origins and destinations (i.e., essentially between Halifax and Montréal or Toronto). It tends to move in solid trains to the extent that this can be arranged. This is especially true for import containers, which arrive by ship at the port in large batches.[4] CN's projected "first round" traffic losses do not include any loss of container traffic. In fact, container traffic **increased** significantly in 1987 due to relocation of shipping lines from Saint John to Halifax. (Data used in CN's analysis represented 1986 conditions.)

In summary, containers form a large and generally stable traffic base whose operating patterns are largely independent of changes in levels and operating patterns of other traffic on the system. In fact, the Port of Halifax's container traffic has been increasing, and is expected to continue to increase in the immediate future years. As container traffic increases, it is reasonable to assume that CN's trains carrying containers will become increasingly dedicated to containers, and therefore less affected by any decrease in non-container traffic.

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[4] Halifax Port Corporation statistics show the average inbound containership load to be 245 TEU's.

Available data were used as follows to estimate the size and relevant characteristics of an "average" container train under 1987 traffic conditions.

A previous study[5] indicated that train lengths are limited to 7,400 feet between Truro and Chicago and to 5,900 feet between Halifax and Truro. The limit on the latter segment is said to be due to siding lengths. For practical purposes, the breakpoint between these two limits would be at Moncton, rather than at Truro. It is not always possible to run trains at the indicated maximum lengths, especially for priority traffic such as containers which must depart on schedule rather than according to train size. It was assumed that CN can achieve, on average, 90% of siding length for the Halifax-Moncton segment, and can fill one half of the additional 1500 feet available between Moncton and Montréal or Toronto. Weighting these factors by mileage and taking a simple average of Montréal and Toronto trains resulted in an average train length of about 5900 feet. At 89 feet per car,[6] this resulted in an average consist of 66 cars. This was reduced to 62 to allow for locomotives and a caboose.

Service levels are said by CN to be two intermodal trains per day in each direction. We understand that the import/export containers move very largely on these intermodal trains. We have therefore assumed in this analysis that all containers move on these trains. Trains are said to operate for virtually the entire year, with minimal breaks for holidays. Assuming 360 days of operation per year, there would be 1440 trains carrying 89,280 carloads per year.

Total container traffic through the port in 1987 was 331,766 TEU's. Seventy percent of this total traffic moves to and from Halifax by rail. With four TEU's per car, this traffic would amount to 58,000 carloads, or about 65% of the total capacity of the container trains described above. This percentage was used to recalculate the effects of traffic decline on variable cost per container.

The projected decline in Atlantic region traffic other than containers was estimated from data supplied by CN. This amounted to 28%. Applying this figure to the non-container portion of the train (assuming no change in the container portion) resulted in a reduction in train size of about 9.8%.

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5 Thorne Stevenson & Kellogg "Rail Movement of Containers Between Halifax and Inland Points", January 1985, Page 10.

6 Many of CN's intermodal cars are 89 feet long, with a capacity of four TEU's.

Switch crews are drawn from a pool at each location (Montréal, Toronto, Moncton and Halifax). Ratios between productive and unproductive time depend on total traffic at these locations, not on the size or composition of particular trains being switched. Therefore, CN's estimated overall traffic loss figure (25%) was retained for calculating cost increases in switching at this point in the analysis.

The above reduction in container train size, together with the switching costs assumption described above were applied to the container train costing model. This resulted in an estimated 7.0% increase in variable cost for the container movement (vs. CN's estimate of 15% to 16%).

It should be noted that the above cost increase estimate applies only to the container traffic. The cost effects of traffic loss on other components of traffic would be different, and in some cases would be expected to be greater than the overall average variable cost increase estimated by CN.

OTHER COST FACTORS

For the most part, CN's selection of costs included in the "shared" category seemed logical. There are, however, grounds for questioning two types of costs selected by CN: costs of diesel units and switching costs.

Diesel Units

CN presented a number of arguments in support of their inclusion of diesel unit costs in the shared variable cost category. CN is reluctant to run fewer than two units per train in case of a breakdown of one unit. Thus, where the trains are presently operating with two units, CN would be reluctant to reduce the consist any further. The type of unit required for branch line operations is not suitable for main line work and vice-versa. This introduces a certain inflexibility into CN's ability to re-assign units in response to changes in traffic. The projected decline in traffic may not be uniform; it may vary by direction. As a result, CN may need to run superfluous units on some trains to position power.

There are, however, a number of considerations that would argue against the inclusion of diesel unit costs in the shared variable category. It is doubtful that CN would maintain a policy of running a second unit just for protection in the face of an extensive and lasting traffic decline. The additional cost would probably be judged too high in such a case. The temporary inflexibility caused by different requirements as between main and branch lines might be overcome in the long run. NTA costing rules require a long-run approach. Even where the locomotive consist has already been reduced to one unit, a reduction in horsepower would be an option in the long run.

Any lack of uniformity in traffic loss is likely to take forms other than an imbalance by direction on the same train run. Many movements have fairly high empty return ratios. In these cases, a decline in demand for power in one direction automatically creates a decline in the other. If the overall traffic loss is 25%, on some train runs the loss may be 35% or 40%. A reduction of diesel power is almost certain in such a case.

The resolution of this question depends partly on the magnitude of the change in train length. Given an estimated average decline in train size of only 9.8%, CN's categorization of diesel unit costs among the "shared" component appears reasonable, for the container trains, and our analysis therefore conforms with CN's position on this issue.

Switching Costs

CN's argument for including switching costs in the shared variable cost category is that switching service is at a "rock bottom" level; CN is, in effect, working with the minimum number of switching crews now. Traffic declines would not lead to fewer crews being called out, but to an increase in unproductive time which would have to be shared out among the remaining traffic. CN state that they have a job security agreement requiring them to pay anyone with over eight years of service.

There are, however, a number of considerations which would argue against the inclusion of switching costs in the the shared variable category. Container traffic moves largely to and from Montréal and Toronto. These are major centres of switching activity, in fact the two largest in the system. In such a large centre, rail management would probably find some way

to re-organize the work in the face of a traffic loss so as to call out fewer shifts, rather than allowing unproductive time to increase.

While Halifax and Moncton are not as significant switching centres as Montréal and Toronto, they are not small. It may be possible to take advantage of economies of scale at these locations in a fashion similar to that described above for Montréal and Toronto.

CN's projected first-round loss of traffic at Halifax itself is considerably smaller than the overall loss estimated for the Atlantic region. No container traffic would be lost, and the decline in traffic likely to share switching shifts with containers is minimal.[7]

As for CN's argument that many of the employees involved must be paid in any case, it is questionable whether costs of redundant employees would be admitted as "variable" under NTA costing rules. This could also be seen as a short-run cost which would be eliminated in the longer run (i.e., as the employees involved retire or find other employment).

In view of the various arguments presented here, two approaches were taken to the treatment of switching costs.

Under the first approach one third of the switching was assigned to each of the three locations involved (Montréal or Toronto, Moncton and Halifax). A separate calculation was made for each location. At Montréal and Toronto it was assumed that management would arrange the work so as to call out fewer shifts, rather than accept increased idle time per shift. In effect, switching costs were not regarded as "shared" at these locations. At Moncton switching costs were treated as part of the shared cost. Switching was reduced by the average projected loss for all Atlantic provinces traffic (25%). At Halifax the average decline in traffic identifiable as Halifax traffic (containers, other port traffic, N.S. autos) in the CN data (about 1%) was applied.

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7 This applies to traffic **identifiable** as Halifax traffic from the data provided by CN. There would be additional traffic switched at Halifax — e.g., "south shore" Nova Scotia traffic — which could not be identified in this way. The impact of this additional traffic appears minimal.

EXHIBIT II-1

COST INCREASES WITH DIFFERENT TRAIN SIZES, TREATMENT OF SWITCHING COSTS

INCREASE IN VARIABLE COST PER CONTAINER*

Decrease in Train Size	Treatment of Switching Cost		
	All Switching Treated as Shared Cost	*Differential Treatment by Location*	*Excluded from Shared Cost*
5%	4.6%	3.0%	2.2%
10%	7.0%	5.5%	4.6%
15%	9.8%	8.2%	7.4%
20%	12.8%	11.3%	10.5%
25%	16.4%	14.8%	13.9%
30%	20.3%	18.7%	17.9%

* Note: All figures presented here reflect an overall loss of 25% in CN Atlantic Region traffic.

The result of this first approach was a further decline in the estimated variable cost increase from about 7.0% to about 5.4% for container traffic.

The second approach was simpler and more aggressive: switching costs were simply removed from the "shared" category altogether. This resulted in an estimated variable cost increase of only 4.6% for container traffic.

SUMMARY OF RESULTS

The results reported above can be summarized as follows:

Assumptions	*Estimated Variable Cost Increase*
CN Assumptions	16.4%
Container Train Size Decline of 9.8%	7.0%
Switching Costs:	
Differential Treatment by Location	5.4%
Exclusion from Shared Costs	4.6%

These are considered the principal results of our analysis. Note that figures shown for switching costs are based on a decline in train size of 9.8%, rather than 25% as assumed by CN. The reduction of cost increase from around 16.4% to about 5% is the **cumulative** effect of changing both types of assumptions (train size and categorization of switching costs).

Additional information is given in Exhibit II-1, **opposite**, which presents results for various combinations of train size and treatments of switching costs. These show increases in the variable cost per container ranging from two to twenty percent depending on the reduction in train size and the treatment of switching costs.[8]

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[8] The differences between the results shown in the first column of this exhibit and those given on page II-4 are due to different underlying assumptions. The figures on page II-4 were based on **total traffic declines** of five, 10, 15 etc. percent, while the figures in the first column of Exhibit II-1 reflect different **declines in the size of the container trains**, with the overall decline in traffic in the region set at 25%. Switching costs behave differently in the two cases, giving rise to the observed differences in the two sets of figures.

INFLUENCE OF INCREASED CONTAINER TRAFFIC

As noted at the beginning of this chapter, the effect of the RTAC/CCMTA proposals on CN's variable cost is tied to a chain of events. Some of these events would occur comparatively slowly. In particular, motor carriers would probably not re-equip themselves with the larger trucks immediately: they would probably phase these in as the present fleet is retired. Container traffic through the Port of Halifax is expected to be increasing during this transitional period.

In order to reflect these considerations the key research results were recalculated based on the level of container traffic through Halifax projected for 1989, i.e., 400,000 TEU's. The assumptions regarding train length, service level and car loading were held constant. This resulted in a reduction in container train size of 6.1%. This, in turn, produced varying increases in variable cost, depending on the treatment of switching cost, as follows:

Treatment of Switching Cost	*Increase in Variable Cost*
Included in Shared Costs	5.1%
Differential Treatment by Location	3.5%
Excluded from Shared Costs	2.7%

CONCLUSIONS

CN's estimate of traffic loss due to the RTAC/CCMTA proposals appears to have been carried out in a careful fashion by CN staff knowledgeable in the relevant areas. In one instance, traffic lost due to factors other than the RTAC proposal seems to have been included. Otherwise, we found nothing questionable in CN's traffic analysis of "first round" traffic losses.

CN's contention that loss of traffic due to the RTAC/CCMTA proposals would cause some increase in the variable cost of transporting containers seems correct. On the assumption that cost and rate are presently more or less equal this would require CN to raise the rate in order for it to remain compensatory.

We believe, however, that certain assumptions underlying CN's cost analysis are open to question. On the basis of alternative and, we believe, more realistic, assumptions, we found CN's estimate of the cost increase attributable to the RTAC/CCMTA proposals to be overstated. We calculated an increase of about 5%[9] in place of the 15% to 16% increase estimated by CN.

Both Peat Marwick's calculations and CN's rest on the assumption that containers do not move in dedicated trains, but are mixed in with other traffic to a certain extent. Efforts were made to verify CN's assertions to this effect, but hard data on the subject were difficult to obtain. If containers do, in fact, move in solid trains, the notion that a loss of traffic would lead to an increase in the **variable** cost of moving containers is not tenable.

The comparatively modest increase in variable cost for container movements estimated by Peat Marwick does not imply that impact of the RTAC/CCMTA proposals on CN's business in the Atlantic Region would be minimal. Although it would appear that container traffic costs would not increase sharply, the variable costs of some other traffic would probably increase more than the thirteen percent average increase used by CN in their calculations, putting the viability of this traffic into jeopardy.

The focus of this investigation has been on the impact on variable costs of traffic loss. An issue of greater moment is the impact of the loss of revenues in relation to the railway's fixed cost burden. To be financially viable, CN must obtain a sufficient contribution[10] from a sufficient volume of traffic to cover all of its fixed costs, including cost of capital. A traffic loss of 25% represents a serious erosion of the railway's revenue. While a good deal of cost would be avoided in not serving the lost traffic, CN would nevertheless lose a substantial contribution to their fixed costs. Moreover, the timing of such a loss would be inopportune, because railway revenues are also expected to be reduced as a result of certain provisions of the National Transportation Act, 1987 which became effective January 1, 1988. Taking all of these factors into consideration, the financial viability of the railway in Atlantic Canada would clearly be threatened.

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9 5% increase for 1987 conditions; 3% increase for expected 1989 conditions.

10 Contribution is the excess of revenue over variable cost.

CN could seek to respond to the revenue losses by raising rates on the remaining traffic. However, opportunities to do this are probably highly limited; CN has been generally free to make such increases in the past, and would likely have done so if market conditions had permitted. CN could also seek to reduce its fixed cost through line abandonments — an initiative it is already pursuing to some degree.[11] However, if more extensive line abandonments become necessary, inevitably even more traffic would be lost.

In sum, it is apparent that the RTAC/CCMTA proposals pose major difficulties for CN in the Atlantic Region, although the impact of these proposals on the variable cost of the container rail movements has not been found to be as large as stated by CN.

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11 The Atlantic Provinces Transportation Commission study "Impact of Future Changes in Railway Services in the Maritime Provinces" (May 1987) concluded that potentially 264 miles of CN's track in the maritimes would be abandoned within five years. The study found that CN could retain some of the traffic associated with these lines through intermodal operations and/or short line railways.

III. COMPARATIVE COSTS OF ALTERNATIVE CONTAINER ROUTINGS

THIS SECTION OF REPORT CONFIDENTIAL

KPMG Peat Marwick

EXHIBIT IV-1

DIMENSIONS OF SHIP-TO-SHORE GANTRY CRANES AT HALIFAX CONTAINER TERMINALS

	CERESCORP	*HALTERM*			
	Crane #'s 1 & 2	*Crane #1 (current)*	*Crane #1 (upgrade Fall 1988)*	*Crane #2*	*Crane #3*
Lifting capacity under spreader	40 t	40 t	40-45 t	40 t	45 t
Outreach from quay	35 m	35 m	37 m	41 m	41 m
Backreach	18 m	18 m	19 m	19 m	19 m
Lift height under spreader	28 m	21 m	28 m	24 m	25 m
Hoisting speed (loaded)	150 ft./min.	80 ft./min.	150 ft./min. (est.)	80 ft./min.	150 ft./min
Trolley travel speed	500 ft./min.	410 ft./min.	500 ft./min. (est.)	410 ft./min.	500 ft./min.

Note: t — tonnes
m — metres

IV. CONTAINER TERMINAL TECHNOLOGY

This chapter describes state-of-the-art container terminal equipment, its applicability to the Halifax container terminals, and its potential for reducing transportation system costs.

SHIP-TO-SHORE GANTRY CRANES

Most ports around the world favour gantry cranes offering a middle range of dimensions, in terms of lift capacity under spreader, outreach from quay, and lift height above quay. Cranes of smaller dimensions, common in the early 1970's, are rarely built now as ship sizes have increased beyond these cranes' capacity to effectively handle them. On the other hand, the demand for cranes of very large dimensions still accounts for only a small share of the market, a share which is only growing slowly. The most sought-after new cranes can lift a safe working load between 31 and 40 tonnes, have an outreach from the quay between 31 and 40 metres, and a lift height above the quay of 26 to 30 metres. Trolley speeds of almost 500 feet per minute, and hoist speeds of 160 feet per minute are now standard. Cranes within these dimensions can effectively load/unload all but the largest ships afloat. In terms of productivity, close to half the gantry cranes in North America achieve an average of between 26 and 30 moves per hour.

The gantry cranes of the Halifax container terminals compare favourably with the specifications listed for a typical good, new crane. Exhibit IV-1, **opposite**, displays the dimensions of the Halifax gantry cranes. Dimensions of the Halterm and Cerescorp cranes fall in the upper half of each range listed, and trolley/hoist speeds are also typical of a modern crane. The handling speed (moves per hour) of both Halifax terminals is in the range of the North American average, but this statistic depends at least as much on a terminal's yard-side handling operations as it does on the physical characteristics of the gantry crane in use.

State-of-the-Art Gantry Cranes

In recent years the leading edge of gantry crane technology has been spurred by three main factors: the need to service ships of increasing size, the use of micro-processor technology in

KPMG Peat Marwick

EXHIBIT IV-2

STATE-OF-THE-ART SHIP-TO-SHORE GANTRY CRANES

Location	*Manufacturer — Year*		*Specifications and Comments*
ECT Rotterdam	Nelcon	1985	• Lifting capacity 50 tonnes • Outreach 40 metres (Panamax) • Lifting height 30 metres • Trolley travel speed 680 feet per minute • Twin trolley system, load swinging suppression • Handling speed (theoretical) 60 moves per hour
Howland Hook, New York City	Paceco	1986	• Outreach 41 metres • Backreach 24 metres • Trolley speed 500 feet per minute • Hoist speed 165 feet per minute • Anti-sway stop device • Fault diagnosis, condition monitoring • Monospar telescopic spreader
La Spezia, Italy	Nelcon/MGM	1986	• Lift capacity 45 tonnes • Outreach 38 metres • Lift height 31 metres • Trolley speed 400 feet per minute • Computer-controlled direct transfer between ship-to-shore and yard cranes — no intermediate handling required. • Simultaneous 2-way operation between cranes • Handling speed (theoretical) 35-40 moves per hour
Felixstowe, U.K.	Davy Morris	1986	• Comparable in size to ECT Rotterdam cranes • "Fast" hoist and trolley speeds • Novel reeving arrangement • Conventional in all other respects (e.g., single hoist) • Handling speed (theoretical) 60 moves per hour
APL Los Angeles and APL Oakland, USA	Tenders issued	1986	• Outreach 46 metres (ultra-Panamax) • Backreach 15 metres • Conventional in all other respects (e.g., single hoist) • Capable to later adapt 2nd. trolley system, and latest computer control technology

Source: "Container crane generation gap begins to widen", Containerisation International Yearbook 1987, p. 20.

the quest for faster handling speeds, and intense competition among crane manufacturers seeking to cut costs. Examples of recently built or commissioned state-of-the-art gantry cranes are shown in Exhibit IV-2, **opposite**. In general these cranes are somewhat larger and faster than the typical cranes described earlier. In particular, the cranes commissioned by American President Lines (APL) were designed to handle the largest container ships afloat ("ultra-Panamax ships") which carry sixteen containers abreast.[1] All of the state-of-the-art cranes were designed to achieve fast handling speeds, the goal being to minimize ships' turnaround times. While manufacturers may claim handling speeds of up to sixty moves per hour, (and such rates have been achieved for limited time periods), in practice these cranes' handling speeds are likely to be much closer to thirty-five moves an hour. Nevertheless, this is a significant improvement over the North American average handling speed of twenty-five moves per hour.

A brief overview of the latest technology employed in these cranes would include the following advancements. The **twin trolley system** allows a crane to continue off-loading a vessel even if a chassis (for example) is not immediately available to receive the container. The container would be temporarily placed on a horizontal platform resting between the quay-side and yard-side legs of the gantry crane. When an empty chassis is available, the second trolley would move the box from the platform to the chassis (i.e., along the backreach segment of the crane's boom). At the same time, the first trolley would have already traversed back to the vessel to unload another container. **Anti-sway stop devices** are microprocessor-controlled devices which allow the driver to suppress load-swinging or correct it quickly by adjusting the acceleration (using acceleration integrators or trolley acceleration boosters located in the electronic control unit). Another computerized system is the **anti-collision system**, intended to protect against the chance of collision between a gantry crane and vessel, the consequences of which are very costly.

Several manufacturers have incorporated microprocessor **fault diagnosis** and **condition monitoring** systems. A number of functions within the crane's control unit are monitored to detect signs of poor performance or trouble. By pinpointing the original fault when a crane is

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[1] There is no known prospect of ultra-Panamax size ships calling at Halifax in the foreseeable future.

in need of repair, the main advantage of fault diagnosis is in minimizing downtime by eliminating the need for manual trouble-shooting.

The new gantry crane in La Spezia, Italy attempts to closely integrate quay-side and yard systems, by directly transferring containers from the ship-to-shore gantry crane to a yard crane, eliminating the need for intermediate handling such as a tractor-trailer system. It also offers simultaneous 2-way operation, that is, direct crane-to-crane container movements in two directions at once.

Aside from not having the latest computer-controlled devices described above, the Halifax gantry cranes differ from the most advanced cranes in two major respects. The physical dimensions of the Halifax cranes are somewhat smaller — i.e., they cannot handle ultra-Panamax vessels. Also, the handling speeds of these most advanced cranes are faster than the cranes in Halifax.

Applicability to Halifax

Although the state-of-the-art cranes are bigger and faster, they are not necessarily suitable for the Halifax container terminals. These cranes are highly costly (upwards of $6.5 million Cdn.) both because of their extra size and advanced technological capabilities. To be cost-effective to the terminal operator, these cranes need to operate as much as possible — at least 5,000 hours per year. Cerescorp and Halterm cranes each typically operate around 2,000 hours per year.

Manufacturers have observed that the costs to achieve modest gains in crane productivity rise sharply, so that advanced cranes are generally not cost-effective for a mid-sized container terminal. Only a very limited number of high volume ports on the main east-west trade routes could make economic use of state-of-the-art cranes.

Leaving aside the issue of high capital costs, the benefits of a crane with a higher handling speed are not immediately apparent in the case of Halifax.

First, it is questionable whether the terminals' existing yard operations could keep up with increased handling speeds. It would be necessary to make improvements to the terminals' yard operations in order to realize the cranes' potential productivity.

Second, assuming the terminals were able to be more productive and ships' turnaround times were reduced, labour costs might remain unchanged since crane and yard equipment drivers must be paid for an entire shift, regardless of whether they work the entire eight hours. While vessel operators do appreciate faster turnaround times, in some cases the increased productivity would not directly benefit the Halifax container terminals. Ships' schedules are not likely to change because of a few hours saved in Halifax; probably the vessels would steam slightly slower to their next port of call, with a modest saving of fuel.

It should be noted however, that container traffic served by the Port of Halifax has increased markedly during the past two years and is expected an increase again in 1988. Halterm will gain Maersk as a customer, and Cerescorp will gain Evergreen. This will put additional pressure on the container terminals' handling capacity.

Halterm, with three gantry cranes, should have sufficient capacity. However, Cerescorp, with two gantry cranes, may be in a position to benefit from a third crane. This may be necessary to maintain fast ship turnaround which is important to the steamship lines. When it becomes apparent that a third crane is needed at Cerescorp, a state-of-the-art gantry crane can be considered. However, as previously stated, these cranes are normally economic only in very high volume container terminals.

MECHANIZED TERMINAL HANDLING SYSTEMS

The yard handling operations of both Halifax container terminals are very similar, and in keeping with conventional terminal operations. Both Halterm and Cerescorp use yard gantry cranes, top-loaders, yard tractors and chassis. In general, both terminals operate as follows. When a vessel is unloaded, the ship-to-shore gantry cranes discharge a box onto a chassis pulled by a tractor (each tractor pulls one chassis). Most containers are then taken beside waiting railcars and immediately loaded onto the railcars by yard gantry or top loader/front loader. Containers destined for local delivery are removed from the chassis (usually by yard gantry) and stored on the terminal, awaiting pick-up by truck. Export operations work basically the same way, with most containers arriving by rail and some by truck. However, relatively few containers move directly from rail to the ship. Containers are stored on the

terminal and arranged for ease of loading. Yard gantries or top loaders/front loaders place containers on chassis which are towed by tractors to the ship-to-shore gantry cranes.

This type of operation is generally typical of container operations around the world. While other handling systems are also used (notably straddle carriers, and even forklift trucks alone), more container terminals use the yard gantry/tractor-chassis combination than any other handling method. Moreover, yard gantries such as 40-ton capacity Transtainers (used by Cerescorp and Halterm) are particularly well suited to handling the rail interface, which accounts for the bulk of moves to/from the Halifax terminals. The yard equipment used by Cerescorp and Halterm is by and large good, modern equipment which compares favourably with container terminals elsewhere.

State-of-the-Art Handling Systems

Recent advances in the design of yard handling systems have not kept pace with the technological innovations seen in ship-to-shore gantry cranes. However, two new developments in use warrant discussion, namely **automated yard gantries** and the **multi-trailer** system.

Yard gantries are well suited to automation for several reasons. Variables which must be considered for ship-to-shore cranes, such as stowage configurations and vessel design and size need not be considered for yard gantries. The narrower range of operations required permit more exact control. Several automatic control devices are available from leading manufacturers such as Hitachi and Mitsui. Rubber-tired yard gantries are available with automatic steering control and positioning, which assist the gantry crane operator, by automatically adjusting the gantry's course, making alignment easier as the gantry passes down a row of containers.

More sophisticated automatic controls have been built into rail-mounted yard gantries since their direction is already determined by the track. These units are capable of operating totally automatically according to a preprogrammed series of moves by using remote, computer-generated instruction sequences. Such a yard gantry can move down a train loaded with containers and unload boxes in a sequence best suited for stowage on a vessel, according to criteria such as destination or weight. In practice, the computer-generated instructions are

usually displayed on a Video Display Unit (VDU) for the gantry operator; nevertheless, the machines are capable of lifting and stacking fully automatically. Highly automated yard gantries should result in more productive yard operations with less time spent between moves, and could also reduce a terminal's labour costs (where fully automatic yard gantries are used).

The multi-trailer system has been implemented in the Europe Container Terminus (ECT) in Rotterdam, the Netherlands. With ECT's system, each ship-to-shore gantry crane is served by two tractors and four trailer-sets, where each trailer-set is comprised of five trailers grouped together. Each trailer-set carries up to ten 20-ft. containers, or five 40-ft. containers.

In a buffer zone beside the container storage area, an uncoupled trailer-set is loaded with containers for export. At the same time, a tractor coupled to another trailer-set is positioned under the ship-to-shore gantry crane, where the containers are loaded onto the vessel. Once finished, the tractor pulls the now-empty trailer-set from the crane to the buffer zone, and uncouples the empty trailer-set. The tractor then couples itself to the second trailer-set, which by this time has been fully loaded with containers ready for export.

According to ECT, the multi-trailer system has resulted in significantly lower transportation costs (savings of about 20%), increased productivity (the ECT Delta Terminal averages 40 container movements per hour), and fewer drivers required for transport per crane, when compared to the typical tractor/yard chassis operation.

Although a number of systems are currently being considered, no fully automated container handling system has emerged past the design stage to date. The common feature of all systems proposed is their very high capital cost. In fact, a major Japanese manufacturer has noted that no system has passed beyond the tendering stage because terminal operators do not believe that the projected productivity gains would justify the high investment cost.[2]

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[2] "Japanese gantry builders take to higher technology", Containerisation International, April 1987, p. 69.

Applicability to Halifax

The two developments referred to above represent the state-of-the-art in mechanized terminal handling systems, but again they are not necessarily suitable for Halifax in the near future. The computer control capability for yard gantries requires a heavy investment by the terminal operator for the hardware and software required, as well as some training of personnel. Meanwhile the Halifax terminals both own at least a sufficient number of good, conventional yard gantries for handling throughput levels foreseeable in the near future.

The degree of investment required for a multi-trailer system depends in large part on the number of trailers combined to form a trailer-set. For instance, the configuration used at ECT Rotterdam requires a heavy-duty tractor capable of pulling five loaded trailers; the cost of each tractor is approximately $230,000. To accommodate the wide (19 metre) turning radius of the tractor and trailer-set, the layout of a typical terminal would likely require major reorganization. However, with a more modest configuration (e.g., two trailers in each trailer-set), conventional tractors could be used, and terminal layout should require a lesser degree of reorganization.

In either case, to achieve productivity improvements to achieve productivity improvements a computerized system would be required to determine an effective combination of containers to be picked up together, according to various vessel-loading requirements (e.g., weight), while also minimizing the distance required to move from container-to-container when taking them from the stacks.

For some container vessels calling at Halifax, the port is the first North American stop for west-bound traffic, and the last stop for east-bound traffic. The containers are either first off the ship or last on the ship, but may be located all over the vessel. These conditions make it more difficult to benefit from a multi-trailer system. The task is simpler at ECT Rotterdam, the system's originator, where volumes are much larger, both in total and by individual containership. Implementing a modest two-trailer system in Halifax could make use of existing yard equipment, namely tractors and chassis, whereas automated yard gantries represent a new (and costly) generation of equipment. Thus, a multi-trailer system seems to warrant further consideration on the part of the Halifax container terminals operators.

INFORMATION TECHNOLOGY

Electronic Data Interchange

The present system of moving containers by rail or ship is dependent on a rather cumbersome flow of information via paper. The purpose of Electronic Data Interchange (EDI) technology is to speed up and improve the transmission of information about any shipment moving between inland rail terminals, containerports, and container vessels. With EDI, information is sent directly from one carrier's computer to that of another carrier in the transportation chain. Information transmittal times formerly of hours or days would be measured in seconds, and the hours of clerical labour greatly reduced.

Recognizing the obvious benefits of EDI to more efficiently transporting goods, North America's major railways and international shipping lines have been rapidly developing EDI capability in recent years. Since the movement of containers by rail is so important to both Halterm and Cerescorp, and since no port can afford to become a bottleneck in the intermodal transportation chain, EDI has become highly applicable, perhaps essential even, to Halifax's containerports. Both container terminal operators are aware of the advantages and increasing necessity of EDI and are currently putting EDI systems in place which will interact with both rail and marine users. The continued development of this technology, and hence the improvement in speed and quality of information exchange, is of immediate benefit to the Halifax container terminals.

Automatic Container Identification

Related to the topic of EDI is the effort being made for more efficient equipment control using automatic container identification. Such systems aim to capture information describing a container's owner, current contents, location, destination, and other details by using micro-processor technology, and update a database in "real-time". Container shippers, owners, and carriers would have instant access to the status of all containers in which they have an interest. A terminal operator, for instance, could know the moment a truck drove through his gate the contents, weight, and destination of a container bound for shipment, and eliminate time-consuming record-keeping done by paper.

Unfortunately, automatic container identification is still only in its early stages. The problems with optical character reading and bar code systems appear to be insurmountable, and research is now concentrated on developing Radio Frequency (RF) systems, whose technology has become more affordable in recent years. RF is a non-contact identification system whereby data contained in a "tag" attached to a container is captured by a stationary antenna, and fed to a control unit for interface with the terminal's host computer. The real value of an automatic identification system would depend on the host computer's software capabilities.

Aside from the high cost of both hardware and software, several other problems remain unresolved. The major barrier to development is the lack of industry standardization, as various manufacturers strive to make their specifications serve as benchmarks for the whole industry. Impetus for development will not come until users are convinced that they are investing in a system with world-wide compatibility, given the global dimensions of the container industry. Thus, while automatic container identification may one day become useful for Halifax, that day is at least as far away as the time it takes for manufacturers to develop an industry standard.

Terminal Operations Control Systems

Terminal operations control systems seek to improve the productivity of yard handling operations and increase management's control of terminal activities, by replacing voice radio (i.e., "walkie-talkies") and paper systems with faster and more useful types of data transmission between the control room and yard-stacking equipment operators. Direct communication between the terminal's host computer and small units inside the cab of yard equipment would replace a controller or supervisor using a walkie-talkie to communicate with the drivers. The benefits of a control system include real-time updating of container movements and control over container stacks, more efficient yard operations and better use of space, better planning tools for management, and closer supervision of yard equipment operators.[3] By considering factors such as the distance a yard gantry would have to travel for a particular move, the length of a container, and the load/discharge mix, the system would optimize handling procedures and minimize empty movements. Virtually all operational facets would be under its control,

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[3] "Receiving the RDT message", Cargo Systems International, July 1987, p. 52.

including container reception and delivery by rail and truck, loading and discharging of vessels, moves within a terminal, and empty and repair stock inventories.

A terminal operations control system requires an investment in, among other things: hardware (keyboard and VDU mounted in cab, hand-held units, communications controller, front end processor, a host computer of sufficient size to drive the system), software for advanced operations planning and the production of management reports, training of employees, and a method of data transmission between host computer and mobile units (cab-mounted and hand-held). Regarding this last requirement, manufacturers have mainly concentrated on two methods of data transmission: Radio Data Transmission (RDT), and infrared.

RDT uses radio waves to transmit information between the host computer and a mobile unit, which then appears as instructions on the driver's video display screen. Operating limits are generally less then 500 metres' distance and under 5,000 bits per second transmission speed.

Many suppliers of RDT components and systems have emerged since the technology was first used at a containerport in the early 1980's. Operators that have invested in RDT systems include terminals in Auckland (New Zealand), Los Angeles (USA), Richmond (USA), Kobe (Japan), Ohi (Japan), Felixstowe (U.K.), Hamburg (West Germany), and Antwerp (Belgium).

Port Rashid (Dubai) serves as an example of the successful application of an RDT system.[4] The increase in container traffic at Port Rashid threatened to swamp the terminal's voice communication capabilities. The port invested in a mobile data system using RDT technology, and installed sixteen terminals in straddle carriers, and another sixteen hand-held models used by roving checkers. All units are connected to a control centre which provides network functions such as transmission sequences and error correction. The port has eliminated its communications bottlenecks since RDT data is transmitted much faster than voice communication, and a driver does not have to wait until a voice channel is free to confirm completion and receive his next assignment. Productivity throughout the port has improved, as cycle times were reduced with the application of computer logic. In addition, management has access to real-time knowledge of operations and storage data.

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[4] "Receiving the RDT message", Cargo Systems International, July 1987, p. 52.

Infrared data transmission relies on a beam of infrared light to transmit data between an antenna and the mobile unit in a driver's cab. ECT/Rotterdam has been using a *vertical* infrared system, where the beam of light is directed vertically upwards by an antenna buried in the terminal's surface. The vertical system presents a serious drawback, since the driver can only send or receive data when positioned directly over the infrared beam. Leaving the stacks just to receive the next set of instructions results in unacceptable delays. Recognizing this, ECT is currently working on the development of a *horizontal* infrared system, so that drivers could send and receive messages within a much larger area.

RDT and infrared each have their advantages and disadvantages.[5] Infrared offers much faster data transmission speed than RDT, and each base transceiver costs about 20% less than an RDT base unit. However, an infrared system requires more transceivers in total, and they are subject to deterioration in bad weather, requiring regular cleaning. An RDT system is unaffected by the weather, but the transmission speed is slower, and because it relies on radio waves, it may at times be affected by other radio equipment.

Halterm and Cerescorp both have in place a certain degree of computerized container control. The terminal operations control systems discussed here represent a significant advancement over their existing systems, principally in the direct computer linking of yard equipment to the host computer, and a more automated process of planning terminal operations. It has been estimated that such a system may increase the yard-side productivity of the Halifax terminals in the range of 8%, by permitting more moves per hour. Given an investment cost of $1 million or more, the terminals may benefit by waiting for price decreases and perhaps technological improvements, since the technology is still relatively new. Nevertheless, this is an area well worth the terminal operators' active consideration. In fact, both terminals are in the process of studying advanced control systems and are already moving in that direction, by currently upgrading their existing computerized terminal operations.

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[5] "Dutch tune in to RDT benefits", Cargo Systems International, January 1987, p. 43.

SUMMARY

The preceding sections considered the applicability to Cerescorp and Halterm of the latest technological developments in three areas: ship-to-shore gantry cranes, mechanized terminal handling systems, and information technology. The conclusions are summarized as follows.

State-of-the-art gantry cranes are very capital intensive, costing upward of $6.5 million. These cranes need a great deal of traffic (e.g., 5,000 hours of operation per year) for the productivity gains to justify the capital investment required. Neither Halifax container terminal approaches the kind of throughput generally required for these cranes.

Traffic continues to increase at Halifax and may put pressure on terminal capacity. Halterm, with three gantry cranes appears to have sufficient crane capacity although Cerescorp, with only two cranes may benefit from a third crane.

Highly automated yard gantries are also highly capital intensive. Similar to the ship-to-shore cranes, this latest generation of yard gantries does not appear to be cost-effective for a terminal the size of Halterm or Cerescorp. Both terminals already own a sufficient number of good, conventional yard gantries for the volumes handled.

A multi-trailer system requires the capability of reorganizing and computer-directing to a greater degree the terminal handling procedures. The size of the investment required depends largely on the length of trailer-sets employed. The nature of Halifax container traffic, being first off the vessel and last on, and often located all over the ship, makes it difficult to implement a multi-trailer system. Nevertheless, a modest system is worth consideration by the Halifax terminal operators, since it could use existing handling equipment and offers potential labour cost savings.

Railways and steamship lines are quickly developing electronic data interchange capabilities, and Cerescorp and Halterm are also adopting this technology. EDI is faster and more effective than paper systems; as well, Halifax must keep up with its rail and marine users if traffic volumes are to be maintained.

The technology of automatic container identification, however, is far from advanced, as some technical problems exist. A consensus on industry standards has not yet been reached, and Halifax will have to wait until global standards have been set. Thus no investment in automatic container identification can be made in the near future by Halterm or Cerescorp.

The terminal operations control systems described earlier represent a big advancement over the existing Halifax computerized container control systems. Yard operations would be planned by computer, and data transmission to the yard equipment would be much faster than by walkie-talkie. Such systems are expensive ($1 million or more), but considerably less costly than the latest ship-to-shore gantry cranes or yard gantries. Investment in a terminal operations control system should be considered for a medium-term time horizon of five years. Both terminal operators are currently upgrading their capabilities in this area and are investigating the latest developments in computerized terminal operations control.

V. DOUBLE-STACK RAIL SERVICE

The potential for double-stack rail service at Halifax is discussed in this chapter.

THE U.S. EXPERIENCE

Double stacking of containers seeks to increase the productivity of container rail operations by increasing the payload of individual trains without jeopardizing service or shifting costs unduly to the terminals. It was introduced by Southern Pacific in 1981, although it was American President Lines (APL) who first committed to a regularly scheduled double-stack service in April 1984. This initiative by an ocean carrier was a logical extension of technological and regulatory developments in the U.S. Other ocean carriers such as NYK, Evergreen and Sea-Land among others soon followed suit, primarily from West Coast ports to Chicago. However, there are few, if any, double-stack rail operations serving U.S. east coast ports at present.

It has been reported that savings of up to 35-40% over the conventional TOFC flat car are achievable on the line haul segment (dropping to 20-25% on a door-to-door basis, including terminal and drayage costs). Further expansion of such services is anticipated with increased back-hauling of U.S. domestic traffic and technological improvements in car design to allow greater flexibility in handling the heavier domestic and overseas containers (e.g., 20-ft. units).[1]

Four double-stack cars are currently vying for favour to carry this traffic in the United States:

- Double-stack articulated 5-platform "LO-PAC" car built by Thrall Car Manufacturing Co. to a Budd design;
- Double-stack articulated 5-platform "Backpacker" car built by Trinity Industries;
- Double-stack articulated 5-platform "Twin-Stack" bulkhead car built by Gunderson/ Greenbrier;

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[1] Burlington Northern has reportedly been testing 5-pack cars with 125-ton trucks to raise platform capacity to 120,000 lbs.

- The Trailer Train "Stand-alone" design, also built by Thrall Car Manufacturing Co.

The Gunderson/Greenbrier car uses a 10-ft. high bulkhead to secure the top container in place. The other models use interbox connectors (IBC's) for this purpose. The Trinity "Backpacker" is similar in concept to the Budd design.

"Stand alone" cars (such as the Trailer Train car) have two sets of trucks for each platform. They do not share trucks between platforms — as is the case with articulated cars. Stand alone cars have greater platform load capacities, but also have heavier tare weights.

In Canada, CP Rail have designed their own 3-platform "stand alone" double-stack car linked by drawbars. They also now favour use of IBC's over the bulkhead option (which they recently abandoned).

Salient features of the cars mentioned above are summarized in the following table.[2]

	Budd "LO-PAC" (Thrall)	*"Back-packer" (Trinity)*	*"Twin-Stack" (Gunderson)*	*Trailer Train Stand Alone*	*CP Rail Stand Alone*
Car Type	articulated	articulated	articulated	stand alone	stand alone
Platforms per Car	5	5	5	1	3
Average Platform Capacity (lbs.)	100,000	102,400	96,000	135,000	180,000
Maximum % 20-ft. Cont. TEU's	20%	20%	20%	100%	100%
Securing Device	IBC	IBC	bulkhead	IBC	IBC
Car Tare Weight (lbs.)	151,000	162,000	194,000	53,100	115,000

[2] Some of the subject cars are available in different configurations (e.g., heavier trucks).

U.S. Rail Cars and Services

The jury is still out in the U.S. on the most appropriate car design, although there are proponents of all four double-stack alternatives. The major criteria for choice of equipment include car weight, aerodynamics and terminal handling effectiveness. Container security has not been a major issue in the U.S.

APL selected the Budd design because of light weight, speed of loading and unloading, and favourable experience with the use of the inter-box connector arrangement for securing containers (IBC's). Each car, consisting of a "five-pack" articulated unit, can carry a minimum of ten 40-ft. containers (20 TEU). However, with 45-ft. wells and 48-ft. boxes above, the effective car capacity is 22.75 TEU. This improves to 25 TEU with the extra height (9'-6") and width 8'-6" of APL's domestic container fleet. APL have now also acquired some cars with capacity to handle 53-ft. containers for domestic operations. With consists of up to twenty-eight 5-pack units, the capacity of individual trains is boosted to 560-700 TEU.

Southern Pacific on the other hand, opted for the Gunderson/Greenbrier bulkhead cars on the strength of aerodynamic characteristics which reportedly reduce drag forces more than enough to compensate for the additional weight penalty of the bulkheads. Sea-Land, Burlington Northern Railroad and the Chessie-Seaboard Railroad also appear to favour this car.

The potential for overload problems, particularly with the increasing popularity of new high cube domestic containers in the U.S., prompted Trailer Train to develop a stand-alone double-stack rail car capable of handling two 48-ft. containers. This car reportedly has a load limit of 135,000 lbs. in contrast to platform-loads for articulated equipment in the range of 90,000 to 100,000 lbs.

U.S. operations are based on relatively long-haul services with turn-arounds geared to vessel arrivals capable of loading an entire train. In this way the inland terminal (e.g., the Global facility in Chicago) becomes the ultimate "turning basin" for the vessel.

THE CANADIAN/HALIFAX CONTEXT

The main flows of maritime containers are between Halifax (Halterm and Ceres terminals) and Toronto (Conport) and Halifax and Montréal (Monterm). There is presently one train per day for each city in each direction. Trains are primarily COFC although additional cars are normally picked up and set out at Moncton (Piggyback and carload traffic). CN is currently using a conventional single-stack flat car 89-ft. long between the couplers.

The average platform capacity of cars equipped with 100-ton trucks (four axles per car) is 198,000 lbs. providing 49,500 lbs. per TEU, more than sufficient to load four 20-ft. units without fear of overloading. (The capacity of cars with 70-ton trucks is less, roughly 38,250 lbs. per TEU.)

Traffic Characteristics

In 1987 international container traffic at Halifax amounted to 317,571 TEU as follows:

		Imports	*Exports*
Tonnes	—	1,290,171	1,427,246
Containers	—	99,462	104,590
TEU	—	154,561	163,010
Percent 20-ft. units	—	44.6%	44.1%

The percentage of empty 40-ft. containers was roughly the same in each direction (15%). However, nearly one quarter (23%) of 20-ft. export containers were shipped empty compared to only 4% in the import direction. This suggests that the 20-ft. unit is not well suited to all Canadian export traffic and probably accounts for the swing towards majority use of 40-ft. units in recent years.

It is estimated that roughly 70% of total containers move by rail, the balance moving by truck or coastal vessel. Of the rail movement it is estimated that 53% is Toronto traffic, about 40% is Montréal traffic and about 7% moves further west to U.S. and other Canadian centres.

The average weight (in metric tonnes) of containers moving over the rails (total weight of loaded containers including tare) was given by CN Rail as follows:

	Import (westbound)	*Export (eastbound)*
20-ft. (includes tare of 2.2 tonnes)	17.0	17.4
40-ft. units (includes tare of 3.9 tonnes)	18.4	23.1

However, container weight varies considerably from one ocean carrier/market to another. Zim Israel Navigation (Zim) for example reported that they average 28.6 tonnes for 40-ft. export containers. Maximum allowable weight is 30.48 tonnes.

Operational Features

The ideal system for double-stack operations is to have a long haul on which to run dedicated trains on a schedule geared to arrival times of the vessel. In this way the line haul becomes an extension of vessel service, the inland terminal becomes a "turning basin" for the ship (the concept of the CNW Global One terminal in Chicago), and the achievable economies are maximized with long trains, and better utilization of equipment.

In terms of distance the CN service may be regarded as medium haul. The distance to Montréal is 763 miles, to Toronto 1,104 miles. This is in the same range as the 923 miles between the Conrail Portside rail terminal in New York and Global One, but less than half the 2,269 miles which separate the Global yard and Los Angeles.

Halifax terminals and rail operations are common user. It is likely that an eventual double-stack service would start out as a mixed train of double-stack and conventional equipment until such time as traffic builds to a level high enough to make a full double-stack train possible. Such a train would compare to the common-user CSX mixed train service currently operating daily between Baltimore and Chicago (Forest Hill yard). An example of full double-stack common-user service is that offered by Burlington Northern (with Gunderson bulkhead cars) between the Seattle International Gateway and Chicago Cicero yard.

Terminal efficiency has been a major focus of U.S. double-stack operations, both at the rail/marine interface and at the inland terminal. The Southern Pacific Intermodal Container Transfer Facility (ICTF) in Los Angeles is an example of planning for efficient, high speed, high volume throughput designed to minimize handling costs at all points in the chain. For example, it reportedly permits for prestaging loads for up to 84 double-stack rail car units and (eventually) direct vessel to rail transfer (reducing "place of rest" costs). Similar improvements have been made at inland terminals, notably at Chicago (Global One, Cicero). The "stop and swap" method at Global One for example simplifies unloading of double-stack cars by placing containers directly onto chassis for TOFC or over-the-road delivery.

Discussion with Halifax terminal operators and with Zim in Montréal suggests that Halifax and inland terminals are relatively well equipped to handle double-stack operations. The recent test by CN of double-stack (see below) did not reveal any major difficulties at the marine terminal. However, the view was expressed that there may be insufficient space at Conport in Toronto (Concord) to handle full double-stack trains.

Results of CN Test

Over a six-month period from November 1985 to May 1986, CN Rail made 27 test runs with double-stack equipment between Conport and the Halterm and Ceres terminals at Halifax. The purpose of this test was to evaluate:

- productivity gains and losses from the point of view of
  - terminal operations
  - train operations
- effects of weather on loading and unloading operations with use of interbox connectors;
- suitability of existing operating and reporting systems.

No major weather-related problems were encountered during these tests. Furthermore, problems related to use of interbox connectors (IBC's) did not materialize. However, with respect to productivity, CN concluded that:

1. Terminal Operators

"Double-stacking does not produce any significant benefits to the terminal operators that offset the increased costs of planning the loading, sorting and handling containers on double-stack cars".

2. Train Operations

"Operating savings to the railway in running the cars are not sufficient to justify the capital outlay while at the same time providing enough room to lower rates to offset the increased terminal expenses".

Our own discussions with the terminal operators (including CN Rail) and with Zim suggests that the principal problem experienced was with the type of rail car used rather than with the terminals, as follows:

1. Terminals

Both Ceres and Halterm were favourably disposed to double-stack operations. While there are some additional costs involved in "mixing and matching", grounding, and in securing containers with IBC.'s, there are also savings relating to the ability to load/unload a greater volume of containers per cut of train length.

2. Car Type

The modified LO-PAC cars are far from ideal for the traffic involved, particularly with respect to platform capacity restrictions (90,000 lbs.).

Ideally, a double-stack car should be flexible enough to carry up to four 20-ft. containers per platform each weighing 20 tonnes, i.e., a platform capacity of 176,320 lbs. Such a car would necessarily be a stand-alone design, a conclusion which CP Rail appears to have reached. However, use of the articulated type shared-truck design might be appropriate for carriers like Zim who use only 40-ft. containers, provided some "mixing and matching" is done to ensure that platform loads are not exceeded. Zim indicated that the "mixing and matching" would be less of a problem under current conditions in view of the larger volume of empties moving eastbound together with the heavy loaded 40-ft. export containers (up to the 30.48 tonnes legal limit).

KPMG Peat Marwick

EXHIBIT V-1

EQUIPMENT SELECTED FOR COST COMPARISON
(Base Case)

	CN Conventional Flat Car (Single-stack)	*Budd "LO-PAC" 5-pack (Articulated Double-stack)*	*CP "Stand-alone" 3-pack (Articulated Double-stack)*
Train consist (cars)			
Container	40	22 (5-pack cars)	33 (3-pack cars)
Other	37	0	0
Length of car (feet) (TEU capacity)	89 (4 TEU capacity)	265 (20 TEU capacity)	180 (12 TEU capacity)
Length of train (feet)	5,900	5,900	5,900
Tare weight of car (lbs.)	64,100	151,000	115,000
Platform capacity (lbs.)	198,900 (no load constraint)	100,000 (load constrained)	180,000 (no load constraint)
TEU's per train	160	440	396
Car capital cost ($)	Based on historic cost/net book value (new car cost $75,000)	245,000	165,000

3. Train Operations

Productivity is maximized with double-stack cars run in full trainloads due to shared costs and better aerodynamic profile (improved fuel efficiency). However, this will only be possible when there is sufficient traffic to move from mixed or conventional trains.

DOUBLE-STACK COST ANALYSIS

In view of the above, we conducted a two-stage analysis to compare the cost of double-stack with single-stack train operations between Halifax and Central Canada. These two stages include a:

- **Base-Case** using a full train load of containers without regard to volume or load limitations;
- **Modified Service** using a mixed train to allow for constraints related to the:
  - relative mix of 20-ft. and 40-ft. containers (currently about 45% of the total is made up of 20-ft. units);
  - the amount of "filler" traffic required for the average train (piggyback and carload), assuming two trains per day in each direction.

The cost analysis work was conducted using a computerized rail costing model developed by Peat Marwick to estimate CN costs. This cost analysis includes ownership costs (i.e., depreciation and cost of capital).

1. Base Case Scenario

Details of the train consist and equipment used for Base Case cost comparison are shown in Exhibit V-1, **opposite**. As detailed there, CN's present service (a mix of conventional container cars and non-container traffic) is compared to two "pure" double-stack trains. Using CN's present service as base = 100, the comparative rail service costs using various equipment alternatives are as follows:

		Comparative Rail Cost
CP stand-alone car	—	78 (i.e., 22% economy)
Budd 5-pack	—	66 (i.e., 34% economy)
New conventional container cars	—	108 (i.e., 8% penalty)

These results show that **if** it were possible to obtain **full double-stack train-loads** without violating load constraints, the Budd LO-PAC equipment would achieve a rail cost saving of about 34% compared to the cost of using CN's existing conventional equipment. For comparative purposes, the analysis shows that costs would increase by 8% if **new** conventional single-stack equipment was used.

This comparative cost advantage of double-stacking is due almost exclusively to the greater carrying capacity of each train.

2. ***Mixed Train Scenario***

The Base Case is clearly unrealistic for the reasons already given. The Budd articulated 5-pack cars as presently constituted[3], are not ideal for the current mix of 20-ft. and 40-ft. containers at Halifax (45% of all containers are 20-ft. units, but this can go as high as 100% in certain cases e.g., ACT/PACE). In addition, total container throughput at Halifax will remain below that required to run full trains into the foreseeable future (i.e., two full trains per day, seven days per week).

Current estimates anticipate 1100 TEU's per day by 1990 (based on an annual total of 400,000 TEU's), of which 70% or roughly 760 TEU's per day will be available for rail, i.e., 380 TEU's in each direction or 190 TEU's per train. This is still below the capacity of a 65-car[4] conventional container train (260 TEU's) and of

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[3] The 5-pack car can accommodate 20-ft. units to a maximum 20% of TEU capacity. However, a 3-pack version would increase the proportion of 20-ft. units to 33% of TEU capacity.

[4] A 65-car "pure" conventional container train is roughly equivalent in length to the mixed train for which data are given in Exhibit V-1.

course well below the capacity of an equivalent double-stack train (up to 440 TEU's).

These several constraints make it necessary to envisage mixed trains of variable length, depending on the car type and on the amount of "filler" available. With the Budd LO-PAC cars (which can accommodate a maximum of 61% of the 20-ft. container traffic at Halifax) trains would consist of double-stack and conventional (single-stack) container cars plus "filler". With the stand-alone car (which can accommodate all 20-ft. containers as well as the 40-ft. units), the train would be a mix of double-stack and "filler".

A second cost analysis was conducted, based on the above assumptions. It was also assumed that the LO-PAC's ability to handle 20-ft. containers would be optimized (i.e., that conventional container cars would be needed for only 39% of these containers). "Filler" traffic was assumed available only up the amount used at present, i.e., the mixed double-stack trains would be shorter than the existing single-stack trains.

Again using the cost of CN's present service as base = 100, the comparative cost of mixed double-stack service with shorter trains is as follows:

		Comparative Rail Cost
CP stand-alone car mixed train	—	82 (i.e., 18% economy)
Budd 5-pack mixed train	—	75 (i.e., 25% economy)

In effect, use of mixed trains makes it possible to achieve only about 70 or 80 percent of the economies achievable with full trains (cf. p. V.8).

The Budd 5-pack car appears to achieve the best results in both the above case and the previous (ideal) case. However, these results are dependant upon very favourable assumptions concerning the ability to provide a traffic mix which can achieve the train loads indicated. In reality, the mix of traffic available at Halifax (including heavily loaded 20-ft. containers) would make it difficult if not

impossible to achieve the economies indicated for the Budd 5-pack cars. In fact, the CP stand alone car probably represents a more practical alternative for Halifax, as it would not be constrained by loading considerations.

CONCLUSIONS

While double-stack rail movement of containers is clearly a promising new development, potential introduction of such service at Halifax is complicated by a number of economic and technological factors which relate to the nature of the traffic moving through the port. These include:

- the need to commit scarce capital resources for what in effect is first generation double-stack equipment which may not be specifically tailored to Halifax container traffic mix;
- the lack of sufficient container volume to maximize the potential economies of this type of equipment/service for the foreseeable future;
- the need for additional investment in container handling equipment and yard space at inland terminals.

While we did not review the complex issue of terminal organization and costs in detail, it would appear that the marine terminals may be better organized and equipped to handle double-stacks than the two inland terminals. Some terminal and equipment modifications would be required at CN's inland terminals (particularly yard layout and operating procedures at Conport) to accommodate double-stack service.

Savings achievable through double-stack operations are significant. However, it is reasonable to expect that savings generated would be shared between the steamship lines and the railway. The railway's share of the savings appear to be insufficient to provide the return on investment needed to justify capital outlays for the new equipment. This conclusion becomes clearer in view of the fact that CN's conventional container cars would probably become surplus to CN's requirement if new cars were introduced. However, at such time as CN requires

additional or new container cars, introduction of double-stack equipment would be much more attractive.[5]

Apart from the above, it is probable that the economics of double-stack service for Halifax would improve if a rail car design better suited to the Halifax traffic mix becomes available. U.S. interest in higher capacity cars, motivated by the growing use of high-cube domestic containers, may lead to the development of such a car. For example, Burlington Northern has recently placed an order for twenty-five double-stack cars with 125-ton trucks.

In view of the **potential** savings which double-stack operations offer, it seems inevitable that double-stack rail service will become a reality at Halifax within the foreseeable future. Moreover, implementation of double-stack in the near-term would benefit promotion of the Halifax containerport image. It would demonstrate that Halifax is "state-of-the-art", and confirm Halifax as a low cost route. However, as previously noted, it seems unlikely that CN itself would have sufficient financial motivation to commence implementation of double-stack at this time.

In the circumstances we recommend that parties interested in the port take action to implement an initial double-stack operation at Halifax, probably one of modest scale. Various possibilities should be explored, including selection of the most suitable origin and destination terminals, the most favourable traffic mix (of one or more steamship lines), and the optimum service schedule. This initiative will require a modus operandi for involvement of CN, one or more steamship lines, and perhaps other parties to develop a practical strategy for a phased introduction of double-stack service.

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[5] Any trend towards use of longer containers at Halifax (45 ft., 48 ft. or 53 ft.) would accelerate the obsolescence of present CN Rail conventional flat car equipment.

VI. CN HALIFAX-MONCTON RAIL LINE

INTRODUCTION

As was noted in Chapter I of this report, information on the condition of the CN Halifax-Moncton rail line was obtained by a track and roadway specialist by means of a trip made over the line in a CN rail-mounted inspection vehicle. The trip was made on March 7 and 8, 1988, and the specialist was accompanied by CN's Maintenance Engineer and the two Roadmasters directly responsible for maintenance of the track. Inasmuch as the significance of the condition of a track at any given time is to some considerable extent related to the type of track construction, the nature of the maintenance input, the speed and volume of the traffic and other factors, these data were also provided by CN and are presented below followed by comment on track conditions observed.

TRACK CONFIGURATION

The total route length between Halifax and Moncton is 188.9 miles, consisting of the 64.9-mile long Bedford Subdivision between Halifax and Truro and the 124.9-mile long Springhill Subdivision between Truro and Moncton. Both subdivisions are a mixture of single and double main track as follows;

Bedford Subdivision		
Halifax (mile 0.0) to Windsor Junction (mile 15.8)	—	double track
Windsor Junction (mile 15.8) to Hyde (mile 61.5)	—	single track
Hyde (mile 61.5) to Truro (mile 64.0)	—	double track
Springhill Subdivision		
Truro (mile 0.0) to Belmont (mil 7.7)	—	double track
Belmont (mile 7.7) to Painsec Junction (mile 117.5)	—	single track
Painsec Junction (mile 117.5) to Moncton (mile 124.9)	—	double track

TRACK STRUCTURE

Rail

Bedford Subdivision

Mile 0.0 to mile 15.6	—	100 lb. ([1]), CWR (2)
Mile 15.6 to mile 37.2	—	132 lb. CWR
Mile 37.2 to mile 61.5	—	115 lb. jointed (3)
Mile 61.5 to mile 64.0	—	100 lb. jointed

Springhill Subdivision

Mile 0.0 to mile 7.6	—	115 lb. CWR
Mile 7.6 to mile 116.6	—	132 lb. CWR
Mile 116.6 to mile 124.7	—	115 lb. CWR
Mile 124.7 to mile 124.9	—	100 lb. jointed

Note: On some of the curves in the jointed rail territory, the jointed rail has been replaced with CWR.

Ties

There are 3,110 hardwood ties per mile throughout the entire route.

Tie Plates

The track is fully tie plated with double shoulder tie plates throughout the entire route.

Ballast

Ballast is crushed rock throughout the entire route.

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[1] Explanation of terms referenced by bracketted numbers may be found at the end of this chapter (starting on Page VI-7).

TRACK MAINTENANCE

Day-to-day maintenance of the track is carried out by the permanent local track maintenance forces comprised of small gangs located at intervals along the track.

Large track rehabilitation programs are accomplished by seasonal specialized gangs equipped with high production machinery specifically intended for the type of work to be done. Generally, such gangs operate over the entire Atlantic region, but some cover a wider territory and some a smaller territory, depending on the type of work. Work carried out by these gangs includes rail renewal programs; tie replacement programs; ballasting programs; track undercutting programs; (4) and road crossing renewal programs.

Significant program work of these types have been carried out in recent years on the Halifax-Moncton line. On the Springhill Subdivision in 1987, for example, the then 100 lb. jointed rail on both tracks of the double track section between mile 0.0 (Truro) and mile 7.6 was replaced with new 115 lbs. CWR; the single track between mile 20 and mile 48 was undercut and new ballast installed and all defective ties replaced; and between miles 41.5 and 61.0 a number of turnouts and road crossings were similarly improved by undercutting, ballasting and tie renewals.

Planned track maintenance program work on the line for the 1988 work season includes:

- track undercutting, the addition of new ballast and replacement of defective ties between miles 7.7 and 20 on the Springhill Subdivision;
- defective tie replacements and track surfacing between miles 117 and 124 on the Springhill Subdivision;
- track surfacing between miles 88 and 117, Springhill Subdivision and miles 17 and 37 on the Bedford;
- undercutting and ballasting of various turnouts and road crossings on the Bedford Subdivision (limits of program not yet finalized);
- replacing of worn rail in various curves on both the Springhill and Bedford Subdivisions;
- continuation of ongoing culvert replacement program on both subdivisions;

- continuation of ongoing program on both subdivisions of replacement of bolted joints between 1/4 mile strings of CWR with field welds.

TRACK INSPECTIONS

Five types of track inspections are carried out as follows:

1. Inspection by a qualified track person, on a track motor car or hy-rail vehicle, three times weekly with not more than two calendar days between inspections. At least one inspection per week is made by the Roadmaster;
2. Inspection by a qualified track person on a train once every three weeks during summer conditions and once per week during winter conditions;
3. Walking inspection by a qualified track person once per year;
4. Operation of CN Test Car (5) over the track two or three times per year;
5. Inspection of rail by rail flaw detector car (6) twice per year.

HOT BOX AND DRAGGING EQUIPMENT DETECTORS (7)

To avoid train accidents caused by overheated freight car wheel bearings and/or dragging equipment, there are a total of six wayside inspection devices on the Halifax-Moncton route for the detection of such train defects. Two of these are on the Bedford Subdivision and four on the Springhill Subdivision.

TRAIN CONTROL SYSTEM

The Automatic Block Signal (ABS) system (8) for train control is employed on the double track portions of the route. On the single track portions, the Centralized Traffic Control (CTC) (9) system is employed.

TRAIN SPEEDS

Maximum permissible train speeds vary between portions of the route (zones) on the basis of type of train (railiner, passenger, freight) and the track curvature and other conditions within each zone. Each zone is identified in the operating timetable by its mileage limits and the maximum permissible speed within that zone is stipulated. The range of maximum permissible speeds in mph currently in effect for the various zones within the two subdivisions on the Halifax/Truro line are shown below.

	Railiner	*Passenger*	*Freight*
Bedford Subdivision	80-25	75-25	60-25
Springhill Subdivision	70-30	70-30	60-30

Within some zones, further speed restrictions are in effect at specific locations such as certain public road crossings.

Train speeds in the ranges outlined above are typical of CN's principal main track across Canada.

ANNUAL GROSS TONNAGE ON THE ROUTE

During the year 1986, the latest full year for which figures were available, the annual gross tonnage (i.e., including locomotives and freight and passenger equipment) carried on the route was as follows:

Bedford Subdivision	—	varied between 11 and 16 million gross tons depending on location
Springhill Subdivision	—	approximately 14 million gross tons

Approximately 50% of these tonnages were carried on each track of the respective double track portions of the subdivisions.

TRACK CONDITION

In addition to observations made while travelling, closer inspection of the track was made from the ground at intervals throughout the route while obtaining train orders by radio from the dispatcher, waiting for passing trains and whenever conditions observed from the car indicated the desirability of stopping for a closer examination.

No unsafe track conditions were observed. Track line, particularly in the CWR territory, is good and no significant deviations in track surface and cross level were observed. The ballast section is very good; i.e., the ballast is crushed rock, the cribs (spaces between ties) are full and there is a substantial ballast shoulder beyond the ends of the ties. Generally, the tie condition is satisfactory. As is normal in all track, some ties are candidates for replacement during the upcoming work season. Turnouts and public road crossings are in generally satisfactory condition.

A number of the public road crossings have been rebuilt in recent years utilizing prefabricated concrete, and full depth rubber or polyethylene slabs in lieu of the usual wood planking or asphalt. Rubber flangeways have been installed at a large number of other crossings. All of these improved crossings are in very good condition.

The numbers of rail anchors in CWR territory conform with requirements but at a few locations some are not tight against the tie. This is not an abnormal condition at this time of year (March), inasmuch as the snow which has covered the ties and anchors for the past several months and has precluded adjustment, has only just disappeared. As long as they are tightened before the onset of high ambient temperatures, the condition presents no hazard.

Overall, the track structure and its condition were found to be satisfactory for the traffic being handled and the permissible train speeds. Presuming continuance of the present quality of track through the necessary maintenance input and component renewal, there is no reason to expect significant operational problems attributable to track condition.

Explanation of Terms

(1) 100 lb. — Rail is usually described by its weight per yard. Thus 100 lb. rail means that it weighs 100 lb per yard, 115 lb. rail weighs 115 lb. per yard, etc. The strength of the rail varies directly with its weight. The heaviest (strongest) rail used on Canadian railways is 136 lbs.

(2) CWR — Abbreviation for "continuous welded rail". Until the 1960's all new rail was installed in track in the 39 ft. lengths received from the mills and the individual pieces connected together with bolts and splice bars. To eliminate the very significant maintenance input required to keep the adjoining ends of the rails in good vertical and horizontal alignment, most railways now weld the individual lengths together into continuous "strings" approximately one quarter mile in length, before installation in track. To reduce welding costs some mills now roll the rail in 78 ft. lengths. More recently, the practice of welding the "strings" together after installation in track has become common, thereby further reducing the number of bolted joints.

(3) Jointed (track) — Track consisting of 39 or 78 ft. lengths of rail with bolted joints between each length; i.e, not welded.

(4) — Removal of existing ballast from the track and replacement with new ballast. This becomes necessary when the existing ballast ceases to provide proper drainage because of pulverization of some of the ballast particles and the entry of earth into the ballast section from the subgrade or other sources. Undercutting is usually done by a contractor using large specialized equipment. The ballast removed is screened and the

reusable material, which depending on conditions will vary from 10 to 15 percent, is replaced in the track. The finer material is wasted on the railway right-of-way. Sufficient new ballast to replace the wasted material is added to the track.

(5) CN Test Car — The car measures and records the actual track condition as it appears under dynamic loading using methods which are state-of-the-art in data acquisition, computer technology and integrated data processing. Because the measurements are made under a moving loaded vehicle, i.e., under dynamic loading, the data obtained are much superior to those obtained in the past using manual methods of measurement on unloaded track.

The CN Test Car is made up of a coach car equipped with computers and recording equipment and an instrumented box car, the weight of which can be varied. The consist is pulled in a train and measures and records the following track parameters:

superelevation	cross level
curvature	surface profile
gauge	track twist

Five different condition reports are produced in real time on-board the car. These reports are utilized by various levels of maintenance personnel for immediate corrective action and short- and long-term maintenance planning.

(6) Rail Flaw Detector Car — Various types of rail defects are cause for removal from track to avoid actual failure of the rail under a train. Certain types can be, and are, detected visually during regular manual track inspection. Others are internal and their detection requires special equipment. On most North American railways including CN, inspection of the rail for internal defects is accomplished by a rail-mounted self-propelled rail flaw detector car in which the special induction and ultrasonic search equipment is housed. Such cars, including the necessary qualified technicians, are available to North American railways from a limited number of contractors on a cost-per-mile-of-testing basis and are utilized extensively.

(7) Hot Box and Dragging Equipment Detector

— The purpose of these devices is to scan passing trains for overheated wheel bearings and dragging equipment such as brake beams, both of which can lead to a derailment. They are installed at 20 to 30-mile intervals depending on local conditions. The detection of overheated bearings is accomplished by heat-sensitive transducers mounted on each side of the track and placed such that they will view the bearings as the train passes the site. These sensors produce an output that is proportional to the infra-red energy being emitted from the bearing being scanned.

For the detection of dragging equipment, a steel plate is mounted between the rails and connected electrically to the trackside equipment. An indicative signal is generated if the plate is struck by anything dragging from the underside of the train.

In both cases, the information is transmitted to the train crew. This may be done by transmission of the signal generated by the detector to a central office where it is interpreted by a skilled operator who in turn advises the train crew by radio. Alternatively the signal may be reported directly to the train crew — either by a wayside "scoreboard" displaying location (by axle count) of the suspect bearing or the dragging equipment, or by a voice synthesizer or "talker" reporting over the train radio. The train is brought to a stop, the defective condition located and appropriate action taken.

(8) ABS — Automatic Block Signal train control system. The basic objective of all train control systems is to ensure the safe and efficient movement of rail traffic from point of origin to destination. Prior to introduction of ABS, train control was exercised through written train orders authorized by a central dispatcher and delivered manually by the station agent to the crew of a train and giving exclusive possession of a specified segment or "block" of the route to a single train. The train order system or modifications of it, is still utilized on portions of Canadian railways where traffic is light.

Basically, ABS is an augmentation of the train order system. In ABS territory, the main line is divided into a series of consecutive blocks. Entry of a train into each block is governed by the aspect displayed by a fixed signal installation at the start of the block. These block signals are automatically controlled by the trains themselves. Presence or absence of a train in the block is determined by an electrical circuit known as a track circuit, which, utilizing the rails as conductors, controls the aspect displayed by the block signal.

(9) CTC — Centralized Traffic Control train control system. CTC is essentially a much sophisticated version of ABS. It is a system of train operation controlled from a central location. It places the control and operation of block signals and switches over an extended territory directly in the hands of the train dispatcher. CTC directs trains entirely by signal indication, operates siding switches and crossovers electrically and automatically informs the dispatcher by visual and audible indications of the location of all trains on the territory. Safety checking resides at trackside where specialized control circuitry, known as vital interlocking control, ensures the fail safety of the system by interconnecting the switches, signals and track circuits in order to prohibit conflicting commands and to prevent unsafe conditions.